

quite characteristic of a number of the smaller *Ogyris* species. It is interesting to note that this race, as in the case of the typical (northern) race, appears always to be associated with other species. The larva located on Mt. Paterwerta in South Australia was accompanied by one of a race of *Ogyris genoveva*, with which species it is commonly associated in Queensland.

Acknowledgements

The author wishes to thank Mr. and Mrs. J. C. Le Souëf for their assistance in making their collection so freely available for examination,

Mr. Charles McCubbin for his information on the South Australian insect, and Mr. D. F. Crosby, Honorary Entomologist at the National Museum, Melbourne, for making this insect* available for examination.

REFERENCES

- Waterhouse, G. A. and Lyell, G. (1914) "The Butterflies of Australia." Angus & Robertson.
Waterhouse, G. A. (1932) "What Butterfly is That?" Angus & Robertson.
McCubbin, Charles (1970) "Australian Butterflies" Nelson.
D'Abrera, Bernard (1971) "Butterflies of the Australian Region." Lansdowne.

The Mollusc *Caryodes dufresnii* in Tasmania

Caryodes dufresnii (Leach) (Mollusca, Pulmonata)

by

RON C. KERSHAW*

and

ALAN J. DARTNALL†

Summary

An account is given of the history of the study of the Tasmanian endemic snail, *Caryodes dufresnii* (Leach). Some account of the variation is given with information on the habits and eggs of the animal.

INTRODUCTION

Tasmania has an interesting fauna and flora not the least of which are the land snails. Many of these have interesting historical associations and they pose intriguing problems of identity, distribution and ecology.

Some of Tasmania's unusual animals are known to have lived in other parts of Australia in the past. But among the land snails are two species which, while related to mainland forms, appear to be truly endemic. One of these is *Auoglypta launcestonensis* (Reeve), a rare and beautiful

snail, which is restricted to the temperate rain forests of north-eastern Tasmania. The second species, the subject of this article, is the *Caryodes dufresnii* (Leach). A highly successful species, it is found in a wide range of habitats throughout the state.

Historical Associations

In 1772 Captain Marion du Fresne brought his two small ships to anchor off south-eastern Tasmania. Marion Bay was named as a consequence of this visit. A sociological milestone of this visit was the first contact with the Tasmanian aborigines. A cultural milestone, a pointer for the future perhaps, was the death of the first aborigine by gunfire. Less well publicised are the collections

*Queen Victoria Museum, Launceston
†Tasmanian Museum, Hobart.

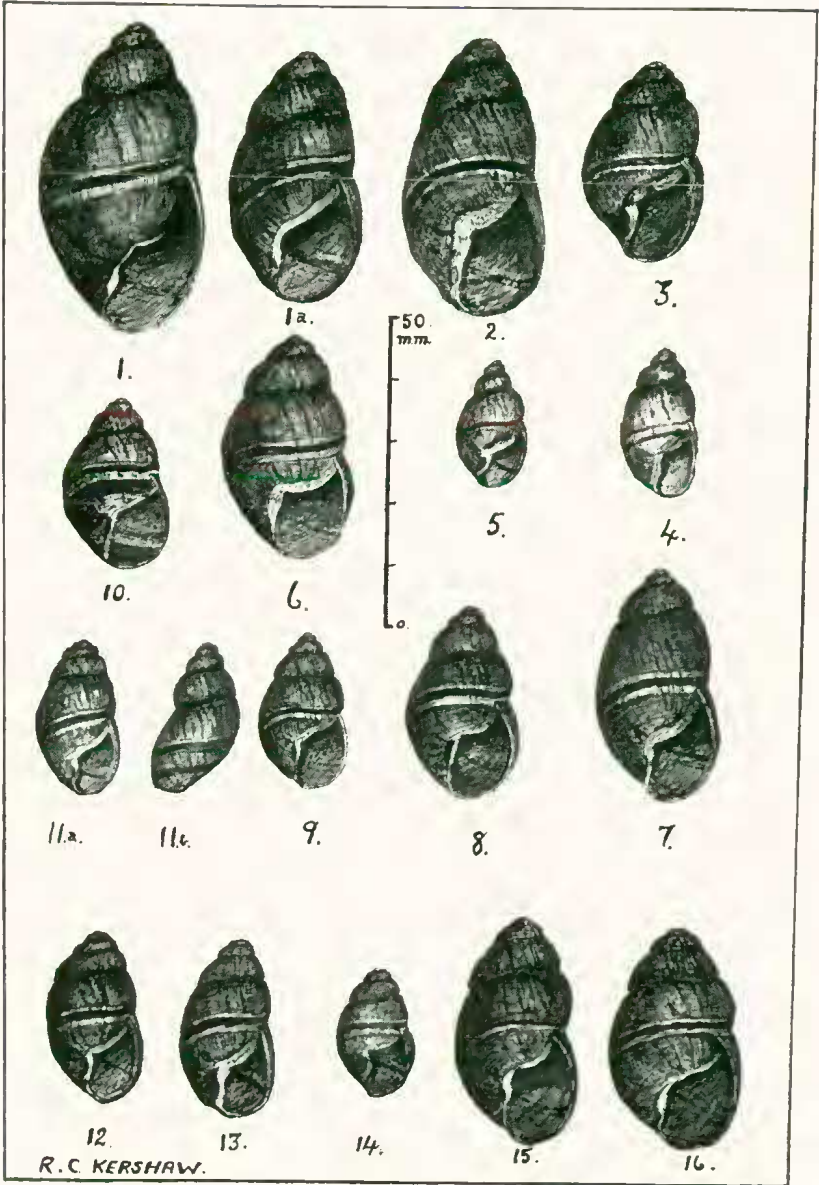


Figure 1. Some shell variations:

made by du Fresne's expedition. The du Fresne collection is now lodged, curiously enough, partly in the Museum d'Histoire Naturelle, Paris and partly in the Royal Scottish Museum, Edinburgh.

Messieurs Quoy and Gaimard, naturalists with the French explorer Jules Dumont D'Urville (Voyage Outour Du Monde De La Corvette L'Astrolabe, 1826-29) visited Tasmania in 1827. They also collected the *Caryodes dufresnii*, however it would appear from their rather unsatisfactory figure (1832) that their specimen was not typical and came from a different area.

Original Description and Identity

Specimens of a snail collected by the du Fresne expedition eventually reached Dr. Leach of the British Museum. They were described by Leach as the new species, *Bulimus Dufresnii*, (Leach, 1815). At the end of his description Leach remarked,

"This new species I have named after M. du Fresne, in his collection (which is ever open for the use of naturalists) it occurs. Inhabits New Holland".

The locality 'New Holland' is hardly specific, and in fact led to confusion as Semper (1870) who first described the anatomy of this snail, gave the Sandwich Islands as the locality.

A tracing from Tab. CXX of Leach (1815) provided by the British Museum (G. L. Wilkins, pers comm. to R. C. K., 1954) has been compared with shells from Tasmanian localities. The form of the shell and the account of du Fresne's expedition leaves little doubt that the type locality is in South-east Tasmania.

The original description, also provided by the British Museum reads: *Bulimus Dufresnii* Tab. CXX.

B. subviolascens-castaneus; anfractu basilari fascia e lineis duabus albis lineaque castanea confecta. Habitat in Australasia.

Mus. Dom. Dufresne.

DUFRESNE'S BULIMUS

Shell chestnut, slightly inclining to violet; the basal whirl with a band composed of one chestnut and two white lines.

The type specimen is apparently lodged in one of the Museums mentioned above; which has yet to be determined. Other localities given for the British Museum are:— Van Dieman's Land, Tasmania (Oyster Cove), and Patterson's River, N. Australia (sic.). The last locality should read:— N. Tasmania. (The authors wish to express their gratitude for the provision of the above information).

Key to Figure 1

1. Rain forest, River Leven Gorge, N. Tasmania.
- 1a. Rain forest, Strahan, Wst. Tasmania.
2. Wet Sclerophyll forest, Flowery Gully, Tamar Valley.
3. Wet Sclerophyll forest, Mt. Wellington.
4. Dry Sclerophyll forest, Swansea, E. Tasmania.
5. Dry Sclerophyll forest, Launceston.
6. Rain forest, Tarraleah, Central Tasmania.
7. Rain forest, Hartz Mountains, W. Tasmania.
8. Wet Sclerophyll forest, Ben Lomond, E. Tasmania.
9. Dry coastal scrub, Greens Beach, Tamar Valley.
10. Dry Sclerophyll forest, Upper Nile R. N. Tasmania.
- 11a. & b. Dry forest near Launceston.
12. Wet Sclerophyll forest, Mt. Wellington.
13. Wet Sclerophyll forest, Mt. Wellington.
14. Dry Sclerophyll forest, Launceston.
15. Rain Forest, Tarraleah, Central Tasmania.
16. Rain Forest equivalent(?), Port Davey, S. W. Tasmania.

Subsequent Literature

As earlier authors have provided references a few important ones only will be quoted here. Iredale (1937) recognised the problems associated with this species but his attempt to divide it into races has not proved successful. Hedley (1892) figured the shell and gave a good description of the animal. Tenison Woods (1878) gave the first illustrated account of the variation. Olive Davies (1914) gave an account of the anatomy. Petterd (1879) also described several variations.

The Problem of Variation

The variability of the *Caryodes dufrenoyi* was first noted by the Rev. Julian Tenison Woods (1878). His published findings illustrates a wide range of variation in this species. He felt that his observations could not be related to climate or situation. His figures are limited to shells from four distinct localities of which only three would possibly differ importantly on the knowledge of his day. He did note, however, that the shell colour was almost always a shade of brown with one or more yellow rings about the body. Accordingly, and this is the important conclusion from his work, he inferred the limits of colour variation in the species. Logically it has led to the study of the relationship between shell colour and environment being carried out by the authors.

In the course of study of a very wide range of shells, some of which are figured (Fig. 1.), the authors have been able only to distinguish two possible consistent forms. Many minor variations exist within populations making premature conclusions unwise. In fact the shell may be short and broad, long and narrow, or long and broad; while the apex may be blunt or sharp. The shell may be thin and fragile or strongly built. Preliminary thoughts suggest environmental controls.

A comprehensive programme to investigate the distribution of the *C. dufrenoyi* is under way. This may indicate whether the observed variation is due to habitat, geology, vegetation or climate, or combinations of these factors. The only conclusion offered at present is that specimens from the temperate rain forest are consistently heavier, larger and darker in colour than those from dry sclerophyll woodland. Logical implications of this are confounded by other complications.

Studies are in progress to evaluate growth changes with a view to eliminating these characteristics from the true variation observed. It must be kept in mind that not all of Tenison Wood's specimens were adult. It seems apparent from careful study that there may be much less real variation than seemed apparent in the past. An example of the problems met is the presence of an umbilicus in certain specimens. Normally there is no umbilicus present. But specimens are known from the vicinity of Ben Lomond in the north-east mountainous part of the State. Recently Mr. John Simmonds of Launceston collected an umbilicated specimen in dry forest near the east coast. A chromosome count from this animal by Mrs. Jean Dartnall revealed no difference between this and animals from the temperate rain forest. The shell has some resemblance to umbilicated specimens from the Ben Lomond area, but is much smaller than the normal rain forest shell.

The Animal

The body of the animal shows some colour variation. Quoy and Gaimard (1832) described the body of their specimen(s) as "brown or almost black, shot with reddish". The foot was yellow below. Charles Hedley (1892) gave the colour as slate, sometimes with a yellowish fringe with the foot greyish yellow. Miss

Davies (1914) recorded greyish brown colouration with a lighter grey foot. The authors have observed animals which are greyish like Hedley's specimens, brown specimens and animals with a distinct pinkish tint. The mantle is most often pale grey but brown animals have a yellow-brown mantle. These animals have all come from different areas. In time it is hoped to establish whether there

is correlation between body colour and shell variation.

Habits

The animal withdraws into its shell folding its body inward upon itself until the mantle closes over it like an envelope. The tail as Hedley noted, is the last part to disappear and the first to reappear. The first sign of activity in an apparently dormant animal exposed to warmth is

Plate 1. *Caryodes dufresnii*, (Leach). The largest specimen is 44 mm (1 $\frac{3}{4}$ inches) long.

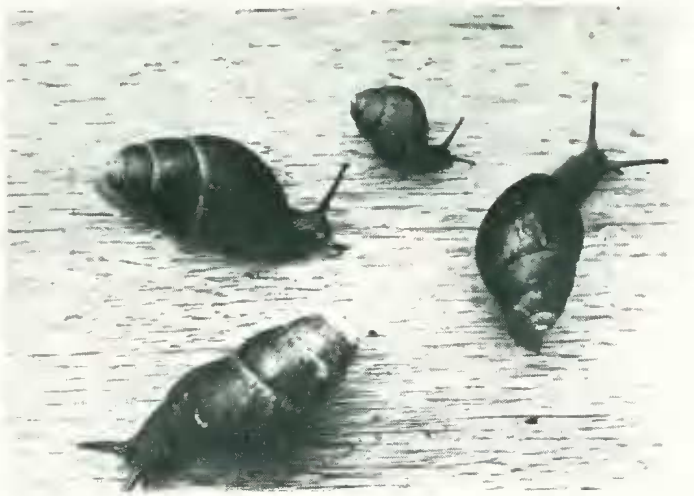


Plate 2 Wet Sclerophyll forest in Northeast Tasmania, haunt of *Caryodes dufresnii*.



the opening of the entrance to the pulmonary chamber. The aperture may remain open for thirty seconds to one minute or more before closing briefly. This rhythm may be maintained for some time, but some animals will begin to move almost immediately. Sometimes small bubbles of freshly exuded mucus may appear.

The darker coloured, tuberculate body surface then begins to appear. Sometimes only a small amount may protrude which then remains stationary for an indefinite period. Eventually the animal folds itself 'inside out'; the foot opening out below and the tentacles appearing as the head leaves the shell. Some animals move about boldly without delay. In alien surroundings there is a tendency to give up exploration in apparent bewilderment. In such cases the animal may return within its shell remaining there until returned to a natural environment. No amount of coaxing has any effect. Placed on grass some will move as close to the soil as possible in a relatively short time. Others may move about briskly without apparent concern.

Caryodes dufresnii is a particularly active snail during wet weather especially at night. It has also been observed climbing trees. Occasional animals are seen crawling on moist forest litter in the morning sunlight. However they are not normally visible during daylight.

Although there may be many snails in a particular area they are often hard to find. In the course of five visits to a study area twenty five live animals were found and thirty empty shells. This represented only one animal to some 40 square yards of forest floor. They are not obviously gregarious animals and seldom more than two are found together. However one of us (A.J.D.) found nine together beneath bark and leaf litter at

the base of a large gum tree. At this site in a south-eastern fern gully, their tree climbing activity was also noted.

The most favoured haunt seems to be beneath rotting logs, or within accumulations of litter alongside logs. In addition to piles of litter at the foot of a tree, large stones in piles particularly when covered with litter are also favoured. In such places the snails may be found several feet down inside the pile.

There are large areas in which snails are not to be found. However, when studying these animals it is desirable to disturb the natural environment as little as possible. Consequently some individuals may escape attention. Only repeated visits especially to densely forested areas bring success. During periods of hot or cold weather the species may be found only in the most sheltered places. In rain forest warm weather after rain often encourages the animals to move about. Much more study of behaviour patterns is needed to explain behaviour patterns in the natural habitat.

Eggs

Tenison Woods (1878) was apparently the first person to describe the eggs of *Caryodes dufresnii*. The eggs are large in relation to the snail. This is one of the characteristics of the group to which the animal belongs. Eggs are reported as appearing in October and November. An egg in the collections of the Tasmanian Museum was taken from Mt. Wellington in July, 1889.

The authors found a "nest" of eggs in October, 1971. The clutch was found at the foot of a tree fern, *Dickinsonia antarctica*, in the dense rain forest of Mt. Arthur in north-eastern Tasmania. Seven eggs were found together just above the ground in the fibrous mat close to the fern trunk. The temperature of the nest

site was 8°C. A thick canopy of dead fern fronds hung beside the trunk providing complete shelter. In this dense and prolific forest the find can only be described as accidental.

The fresh appearance of the eggs suggested a recent laying and careful search revealed two adult snails close by. This lent weight to the idea that the two had recently mated and deposited their eggs there. The eggs were elongate oval, 11 mm by 7 mm and coloured dull greyish-white. In strong light they appeared slightly translucent and creamy in colour. It is possible that the egg shell is flexible and expands and hardens when laid. However egg laying and mating have not yet been observed.

Two eggs were retained by R. C. K. the remainder by A. J. D. to be placed in the Tasmanian Museum. The two eggs retained by R. C. K. were kept in litter maintained at approximately 8°C. These hatched in December 1971 between nine and ten weeks after collection. The following description was made of these specimens at about four weeks of age.

Whorls approximately three, ovately globose, surface glossy pale reddish-brown horn translucent. Body whorl encircled by one pale reddish-brown band and two pale translucent greyish bands, the width of the three less than 0.5 mm. Shell 10 mm wide, 9 mm high; aperture 8 mm high, 7 mm wide.

Protoconch about half a whorl, approximately 0.4 mm across at widest, depressed below level of next whorl with depressed nucleus. Protoconch sculpture obsolete traces of spiral riblets; colour glassy pale horn, smooth in texture.

Subsequent sculpture abruptly commencing at end of protoconch, about 18 spiral riblets by end of first whorl, bolder at the periphery. Riblets crossed by radial shallow

furrows producing a wave like effect and breaking the riblets into slightly elongated tubercles. Interstices with extremely fine radial striae.

Animal with foot about 10 mm long, 3 mm wide, under side very pale translucent lemon, upper part of foot pale yellowish grey passing into black on the upper parts of the body and the tentacles; the whole ornamented with very weak elongate tubercles.

Base of shell smoother with weaker sculpture than upper surface. Umbilicus minute, deep, partly obscured by the columellar reflection.

Feeding Habits

The *Caryodes dufresnii* is apparently vegetarian, consuming decaying vegetable matter and fungi. In captivity the animals live well on a mixture of peanut butter, rolled oats and 'vegemite' seasoned with powdered calcium carbonate. They will also eat some green vegetable matter. The radula possesses about 170 rows of 85-90 simple teeth which would also indicate a herbivorous habit.

On three occasions, once in the field and twice in captivity, a specimen has been found with its head inserted within the shell of another in the manner of a carnivorous snail. On the second occasion this excited considerable curiosity because no dead shells had been placed in the container. A day or two later a similar event occurred and a search revealed further empty shells. A search for a suspected predator did not reveal such an animal. However the depth of litter may hide a dead animal long enough for the shell to become empty. The close search made revealed several in various stages of decomposition. No further cases of intrusion upon empty shells has been seen and the activity remains unexplained.

Predators

Birds and mammals are probably the most obvious predators of the

Caryodes dufresnii, Broken shells have been found in "runs" or scattered on the forest floor. The first situation suggests animal predators. A collection from such a site revealed several with a body whorl removed and one without a spire. Scattered shells may result from the activities of birds or possums. More observations are needed on this matter.

When carnivorous snails are the predators the shell is completely cleaned out. It is normally found undamaged beneath a log or other shelter. Species such as *Strangesta ruga* (Legrand) are commonly found in association with *Caryodes* animals. A description of the habits of the carnivorous snails is given by Smith (1971).

Dead shells are sometimes found in caves. In most cases there is little doubt that they have been washed into the caves. No live animals are known to have been found in such situations. A typical collection obtained from the Mole Creek area revealed only old, worn specimens most likely transported. Many years ago Mr. Edmund Gill of the National Museum collected both shells of *Caryodes* and an aboriginal implement from a cave at Flowery Gully near the Tamar River. He raised the point (pers. comm. to R. C. K., 1955) as to whether the aboriginals may have handled the shells. These people certainly would have been aware of this large and common mollusc.

Origin

Many members of the Tasmanian snail fauna have close relatives in Victoria. In some cases the species appear identical. There seems little doubt that during the last Pleistocene glaciation the faunas of Tasmania and S. E. Australia were continuous across Bass Strait. It is therefore an interesting exercise to ask why the

Caryodes dufresnii is found only in Tasmania.

The acavid molluscs to which the species belongs have a number of representatives in Eastern Australia. They all possess widely different shell forms, but have similar reproductive anatomy and chromosome numbers (Dartnall and Dartnall, 1972). It is possible that the *C. dufresnii* evolved from an animal like the Victorian species *Pygmipanda kershawi* losing four chromosomes in the process (58-54). We now need to look for traces of parent populations that carry some resemblances to the mainland form. It is hoped that the study of variation at present in progress may shed some light on this idea. Fossil remains may also help. Enquiry of Dr. Brian Smith reveals that no fossil *Pygmipanda* are known in Victoria.

REFERENCES

- Dartnall, A. J. & Dartnall, Jean A., 1972. "Notes on the Reproductive Anatomy and Cytogenetics of some Australian Acavacean Molluscs." *Aust. J. Zool.* 20 (1).
- Davies, Olive, 1914. "The anatomy of *Caryodes dufresnii*, (Leach)." *Proc. Roy. Soc. Victoria*, 27 (n.s.) (1): 19-24.
- Hedley, C., 1892. "On the anatomy of Some Tasmanian Snails." *Proc. Linn. Soc. N.S.W.*, 6, 19, Pt. I, f. 1, Pt. 2, f. 1.
- Leach, W. E., 1815. "Zoological Miscellany" London. 2: 154.
- Petterd, W. F., 1879. "A Monograph of the Land Shells of Tasmania." Launceston.
- Quoy et Gaimard, 1832. "Voyage de l'Astrolabe." *Zool.* 2: Pl. X.f.1
- Semper, 1870. *Reis. im Phil.* iii p. 103, Pl. 12, F. 23-5, Pl. 16, F. 7.
- Smith, B. J., 1971. "Carnivorous Snails of the Family Paryphantidae". *Aust. Nat. Hist.* 17: 55-58.
- Tenison Woods, J., 1878. "On *Bulimus Dufresnii* Leach". *Proc. Linn. Soc. N.S.W.* 3: 89-91, Pl. 7.